

REMARKS

Claims 1-51 were previously pending, of which claims 4, 17 and 25-51 were withdrawn in response to the Restriction Requirement dated July 22, 2005. Claim 16 is cancelled. Claims 5, 11, and 12 are amended. Reconsideration of presently pending claims 1-3, 5-15, 18-24 is respectfully requested in light of the above amendments and the following remarks.

Claim Objection, Claim 5

Claim 5 is objected to for reciting 500 to 10000 standard centimeters per minute (sccm). By this response, claim 5 is amended to recite 500 to 10000 standard cubic centimeters per minute (sccm) as suggested by the examiner. Accordingly, Applicants respectfully request the withdrawal of the objection to claim 5.

Rejections under 35 U.S.C. §102(b), Claims 1-3, 10-15, and 24

Claims 1-3, 10-15, and 24 are rejected under 35 U.S.C. §102(b) as being allegedly anticipated by Raaijmakers, et al. (US Patent Publication No. 2001/0054769 hereinafter referred to as "Raaijmakers").

The PTO provides in MPEP § 2131 that

"[t]o anticipate a claim, the reference must teach every element of the claim...."

Therefore, with respect to claim 1, to sustain this rejection the Raaijmakers patent must contain all of the above claimed elements of the claim. However, contrary to the examiner's position that all elements are disclosed in the Raaijmakers reference, the reference does not disclose flowing a nitrogen containing reactant into said ALD process chamber so that said nitrogen containing reactant is deposited on said substrate, purging said ALD process chamber with an inert gas to leave a monolayer of nitrogen containing reactant on said substrate, flowing a

metal precursor into said ALD process chamber, said metal precursor reacts with said nitrogen containing reactant monolayer to form a metal nitride monolayer, and purging said ALD process chamber to remove unreacted metal precursor.

The examiner alleges that Raaijmakers discloses these features in paragraphs 126-132 and in Table II, which is shown below:

TABLE II

Phase	Carrier Flow (slm)	Reactant	Reactant Flow (secm)	Temperature (° C.)	Pressure (Torr)	Time (sec)
metal	400	TiCl ₄	20	400	10	.05
purge	400	—	—	400	10	0.8
nitrogen	400	NH ₃	100	400	10	0.75
purge	400	—	—	400	10	1.0

In the above sections and in Table II, Raaijmakers merely discloses an ALD process in which "in the first phase of the first cycle, TiCl₄ chemisorbs upon exposed surfaces of dual damascene trenches and contact vias... formed to block pores in the low k material... After the TiCl₄ flow is stopped and purged by continued flow of carrier gas, a pulse of NH₃ is supplied to the workpiece.... The NH₃ reacts with the chloride-terminated surface of the metal monolayer... forming a monolayer of titanium nitride (TiN).... Neither ammonia nor the carrier gas further reacts with the resulting titanium nitride monolayer, and the monolayer is left with the resulting titanium nitride monolayer, and the monolayer is left with a nitrogen and NH_x bridge termination."

Thus, instead of flowing a nitrogen containing reactant into the ALD process chamber so that said nitrogen containing reactant is deposited on said substrate, Raaijmakers first flows a metal (TiCl₄) into the ALD process chamber to block pores of the low k material. Instead of flowing a metal precursor into the chamber to react with the nitrogen containing reactant monolayer to form a metal nitride monolayer, Raaijmakers flows a nitrogen containing reactant (NH₃) into the chamber to react with the metal precursor to form the titanium nitride monolayer.

In other words, the order of and chemicals used in the ALD process steps performed by Raaijmakers are different from the presently claimed invention.

In addition, contrary to the presently claimed invention in which a nitrogen containing reactant is first flowed into the process chamber to be deposited on the substrate, all of the ALD processes that Raaijmakers discloses in Tables II, III, IV, V, and VI require a flowing of a metal, such as $TiCl_4$, into the process chamber first before purging and flowing of nitrogen. Therefore, Raaijmakers fails to disclose the features of claim 1.

With regard to claims 11 and 12, Raaijmakers does not disclose flowing a metal precursor into said ALD process chamber, so that metal precursor is deposited on said substrate, wherein said metal precursor is $Ti\{OCH(CH_3)_2\}_4$, TDMAT, TDEAT, or TBTDET. As discussed above in arguments presented for claim 1, Raaijmakers discloses a metal precursor such as $TiCl_4$. In Tables III, IV, and VI, Raaijmakers discloses a metal precursor such as WF_4 . In Table V, Raaijmakers discloses a metal precursor such as $CuCl$. However, Raaijmakers does not disclose a metal precursor such as $Ti\{OCH(CH_3)_2\}_4$, TDMAT, TDEAT, or TBTDET. Therefore, Raaijmakers does not disclose the features of claims 11 and 12.

Accordingly, Applicants respectfully request the withdrawal of the rejection to claims 1-3, 10-15, and 24 under 35 U.S.C. §102(b).

Rejections Under 35 U.S.C. §103(a), Claims 5-9

Claims 5-9 are rejected under 35 U.S.C. §103(a) as being allegedly unpatentable over Raaijmakers. Applicants traverse this rejection on the grounds that the reference is defective in establishing a *prima facie* case of obviousness with respect to claims 5-9.

As the PTO recognizes in MPEP § 2142:

*... The examiner bears the initial burden of factually supporting any *prima facie* conclusion of obviousness. If the examiner does not produce a *prima facie* case, the applicant is under no*

obligation to submit evidence of nonobviousness...

It is submitted that, in the present case, the examiner has not factually supported a *prima facie* case of obviousness for the following, mutually exclusive, reasons.

1. The Reference Does Not Teach the Claimed Subject Matter

The Raaijmakers patent cannot be applied to reject claims 5-9 under 35 U.S.C. § 103(a), because Raaijmakers fails to disclose or suggest the features of claim 1, from which claims 5-9 depend. As discussed above in arguments presented for claim 1, Raaijmakers fails to disclose flowing a nitrogen containing reactant into said ALD process chamber so that said nitrogen containing reactant is deposited on said substrate, purging said ALD process chamber with an inert gas to leave a monolayer of nitrogen containing reactant on said substrate, flowing a metal precursor into said ALD process chamber, said metal precursor reacts with said nitrogen containing reactant monolayer to form a metal nitride monolayer, and purging said ALD process chamber to remove unreacted metal precursor. Instead, Raaijmakers discloses an ALD process that requires a flowing of a metal, such as TiCl₄, into the process chamber before purging and flowing of nitrogen. Since there is no disclosure or suggestion of flowing a nitrogen containing reactant into said ALD process chamber to be deposited on the substrate or flowing a metal precursor into said ALD process chamber to react with the nitrogen containing reactant monolayer to form a metal nitride monolayer, one of ordinary skill in the art would not have been led to modify the disclosures of Raaijmakers to reach the presently claimed invention.

Thus, for this mutually exclusive reason, the examiner's burden of factually supporting a *prima facie* case of obviousness has clearly not been met, and the rejection to claims 5-9 under 35 U.S.C. §103(a) should be withdrawn.

Rejections Under 35 U.S.C. §103(a), Claims 23

Claim 23 is rejected under 35 U.S.C. §103(a) as being allegedly unpatentable over Raaijmakers in view of Kim, et al. (US Patent No. 6,270,572 hereinafter referred to as “Kim”). Applicants traverse this rejection on the grounds that these references are defective in establishing a *prima facie* case of obviousness with respect to claim 23.

As the PTO recognizes in MPEP § 2142:

*... The examiner bears the initial burden of factually supporting any *prima facie* conclusion of obviousness. If the examiner does not produce a *prima facie* case, the applicant is under no obligation to submit evidence of nonobviousness...*

It is submitted that, in the present case, the examiner has not factually supported a *prima facie* case of obviousness for the following, mutually exclusive, reasons.

1. Even When Combined, the References Do Not Teach the Claimed Subject Matter

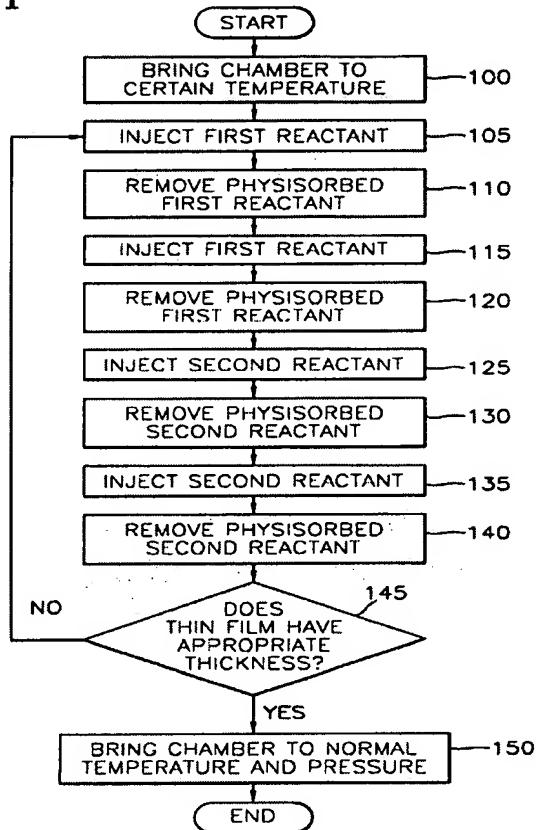
The Raaijmakers and Kim patents cannot be applied to reject claim 23 under 35 U.S.C. § 103(a), which provides that:

A patent may not be obtained ... if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains ... (Emphasis added)

Thus, when evaluating a claim for determining obviousness, all limitations of the claim must be evaluated. As discussed above in arguments presented for claim 1, from which claim 23 depends, Raaijmakers fails to disclose flowing a nitrogen containing reactant into said ALD process chamber so that said nitrogen containing reactant is deposited on said substrate, purging said ALD process chamber with an inert gas to leave a monolayer of nitrogen containing reactant on said substrate, flowing a metal precursor into said ALD process chamber, said metal precursor

reacts with said nitrogen containing reactant monolayer to form a metal nitride monolayer, and purging said ALD process chamber to remove unreacted metal precursor. Kim also does not disclose or suggest such features. Fig. 11 of Kim is shown below:

FIG. 11



As shown in Fig. 11, Kim first injects the first reactant into the chamber two times before injecting the second reactant into the chamber two times. However, Kim fails to inject any metal precursor into the chamber to react with the first or second reactant to form a metal nitride monolayer. Therefore, in addition to Raaijmakers, Kim also does not disclose or suggest the features of claim 1, from which claim 23 depends.

Thus, for this mutually exclusive reason, the examiner's burden of factually supporting a *prima facie* case of obviousness has clearly not been met, and the rejection to claim 23 under 35 U.S.C. §103(a) should be withdrawn.

2. The Combination of References is Improper

Assuming, arguendo, that none of the above arguments for non-obviousness apply, there is still another, mutually exclusive, and compelling reason why the Raaijmakers and Kim patents cannot be applied to reject claim 23 under 35 U.S.C. § 103(a).

§ 2142 of the MPEP also provides:

...the examiner must step backward in time and into the shoes worn by the hypothetical 'person of ordinary skill in the art' when the invention was unknown and just before it was made.....The examiner must put aside knowledge of the applicant's disclosure, refrain from using hindsight, and consider the subject matter claimed 'as a whole'.

Here, neither Raaijmakers nor Kim discloses, or even suggests, the desirability of the combination to perform a film thickness measurement after several repetitions of the sequence of steps (c), (d), (e), (f) to determine if an acceptable thickness of said metal nitride layer has been achieved as specified above and as claimed in claim 23.

The examiner alleges that it would have been obvious to one of ordinary skill in the art at the time the invention was made to perform a measurement of the thickness of the layer as Kim and Raaijmakers disclose in order to ensure a sufficiently thick metal nitride to serve a barrier function in the dual damascene structure. Applicants respectfully disagree. As discussed above in arguments presented for claim 1, Raaijmakers does not disclose flowing a nitrogen containing reactant first into the chamber to be deposited on the substrate. Instead, Raaijmakers discloses that metal is to be first flowed into the chamber. Kim, on the other hand, fails to even mention flowing a metal into the process chamber. Kim only injects a first and second reactant into the process chamber twice. Therefore, one of ordinary skill would not have been led to modify or

combine the disclosures of Raaijmakers and Kim to perform a film thickness measurement after several repetitions of the sequence of steps (c), (d), (e), (f) to determine if an acceptable thickness of said metal nitride layer has been achieved, because neither Raaijmakers nor Kim discloses or suggests the steps of (c), (d), (e), (f) as recited in claim 1.

In addition, since there is no mention in either reference of flowing a nitrogen containing reactant into said ALD process chamber so that said nitrogen containing reactant is deposited on said substrate or flowing a metal precursor into said ALD process chamber, said metal precursor reacts with said nitrogen containing reactant monolayer to form a metal nitride monolayer, the resulting combination of Raaijmakers and Kim would not be the same as the features recited in claim 1, from which claim 23 depends.

Thus, it is clear that neither patent provides any incentive or motivation supporting the desirability of the combination. Therefore, there is simply no basis in the art for combining the references to support a 35 U.S.C. § 103 rejection.

In this context, the MPEP further provides at § 2143.01:

The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination.

In the above context, the courts have repeatedly held that obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching, suggestion or incentive supporting the combination.

In the present case it is clear that the examiner's combination arises solely from hindsight based on the invention without any showing, suggestion, incentive or motivation in either reference for the combination as applied to claim 23. Therefore, for this mutually exclusive reason, the examiner's burden of factually supporting a *prima facie* case of obviousness has clearly not been met, and the rejection to claim 23 under 35 U.S.C. §103(a) should be withdrawn.

Conclusion

It is clear from all of the foregoing that independent claims 1, 11, and 12 are in condition for allowance. Dependent claims 2-3, 5-10, 13-15, and 18-24 depend from and further limit independent claims 1, 11, and 12, and therefore are allowable as well.

An early formal notice of allowance of claims 1-3, 5-15, and 18-24 is requested.

Respectfully submitted,



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